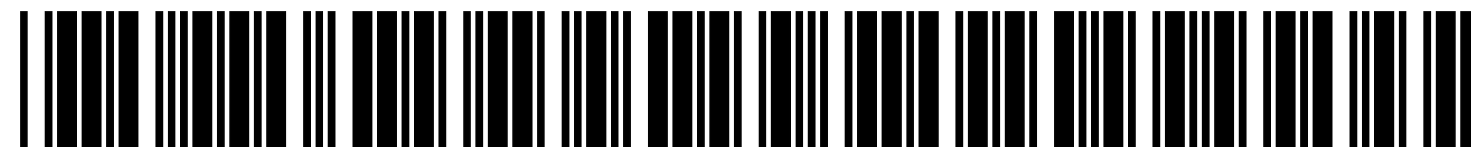
US011087958B2

(12) **United States Patent**
Mizuno

(10) **Patent No.: US 11,087,958 B2**
(45) **Date of Patent: Aug. 10, 2021**

(54) **RESTORATION METHOD FOR PLASMA PROCESSING APPARATUS**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 51 days.

(21) Appl. No.: **16/260,610**

(22) Filed: **Jan. 29, 2019**

(65) **Prior Publication Data**

US 2019/0385818 A1 Dec. 19, 2019

(30) **Foreign Application Priority Data**

Jun. 15, 2018 (JP) JP2018-114256

(51) **Int. Cl.**
C23C 16/44 (2006.01)
H01J 37/32 (2006.01)
C04B 41/89 (2006.01)
C04B 41/52 (2006.01)

(52) **U.S. Cl.**
CPC ***H01J 37/32091*** (2013.01); ***C04B 41/52*** (2013.01); ***C04B 41/89*** (2013.01); ***C23C 16/44*** (2013.01); ***H01J 37/32541*** (2013.01)

(58) **Field of Classification Search**
CPC C23C 16/44; C23C 16/52; C04B 41/52; C04B 41/89; H01J 37/32091; H01J 37/32541
See application file for complete search history.

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Primary Examiner — Bret P Chen
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(57) **ABSTRACT**

According to one embodiment, a restoration method for a plasma processing apparatus is provided. The method includes performing application of a restoration liquid from a coating part onto a consumed region on a component for serving as a constituent element of the plasma processing apparatus, by controlling positions of the component and the coating part, and an application amount of the restoration liquid; and solidifying the restoration liquid applied on the component.

5 Claims, 8 Drawing Sheets

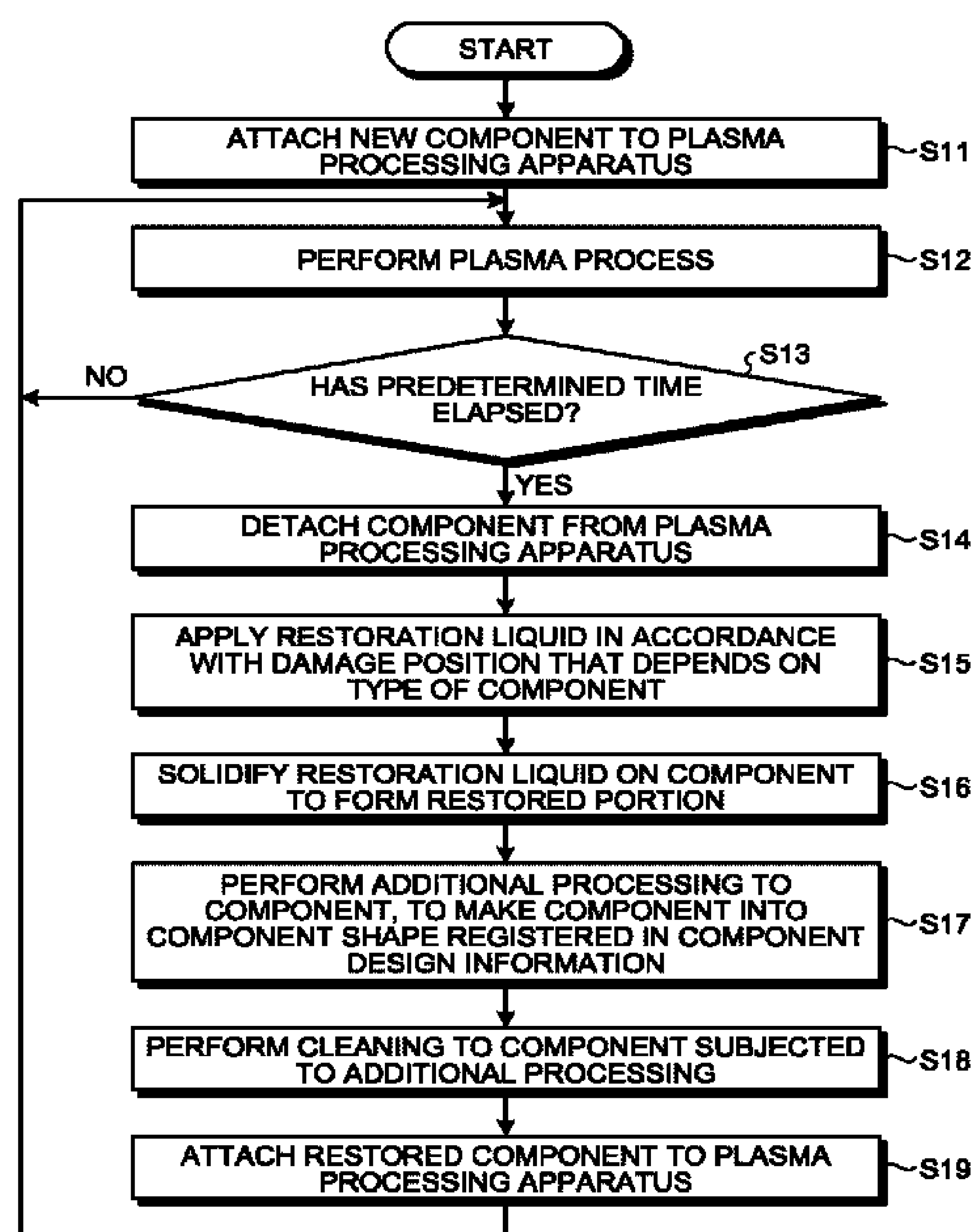

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FIG.1

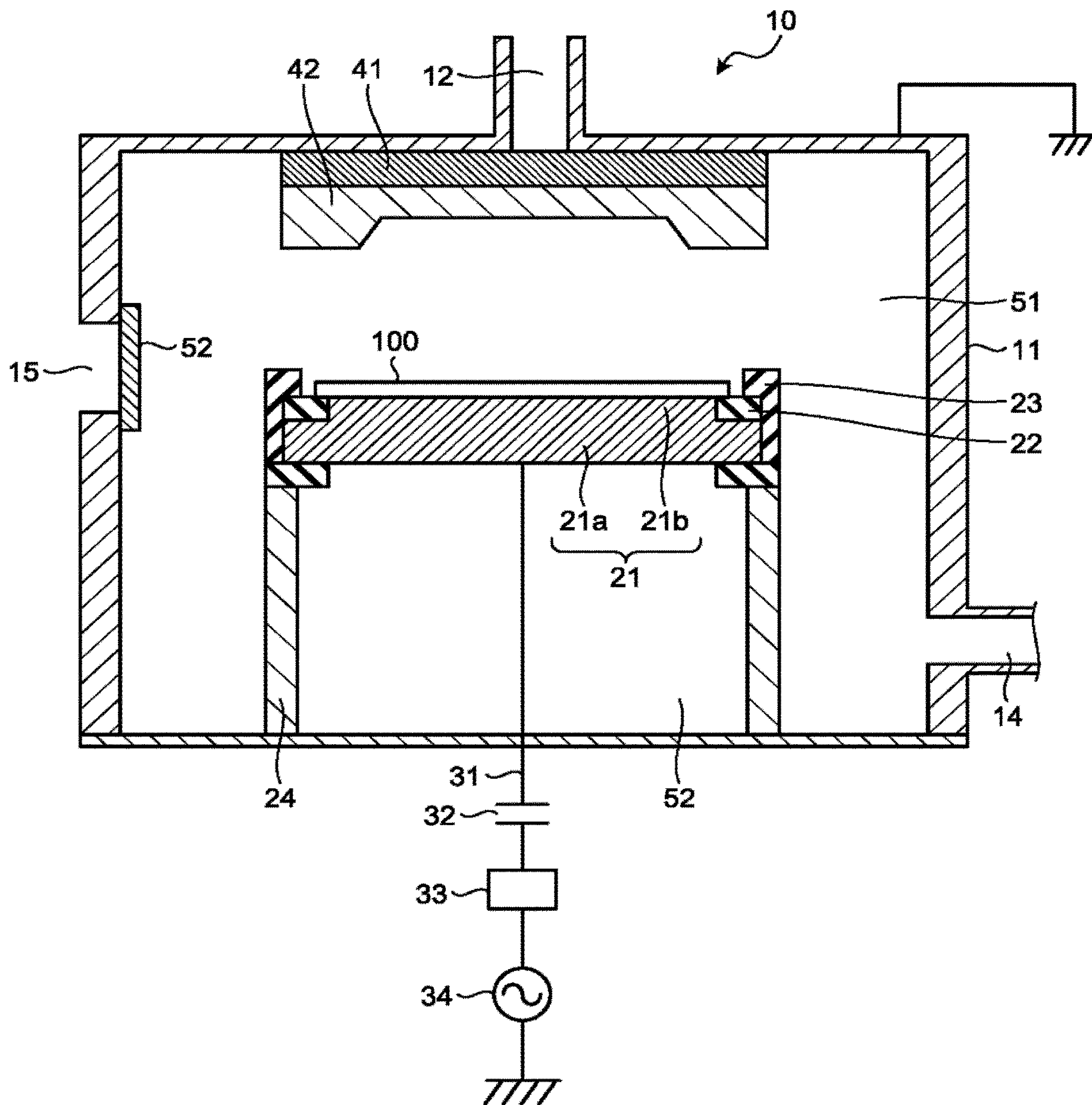


FIG.2

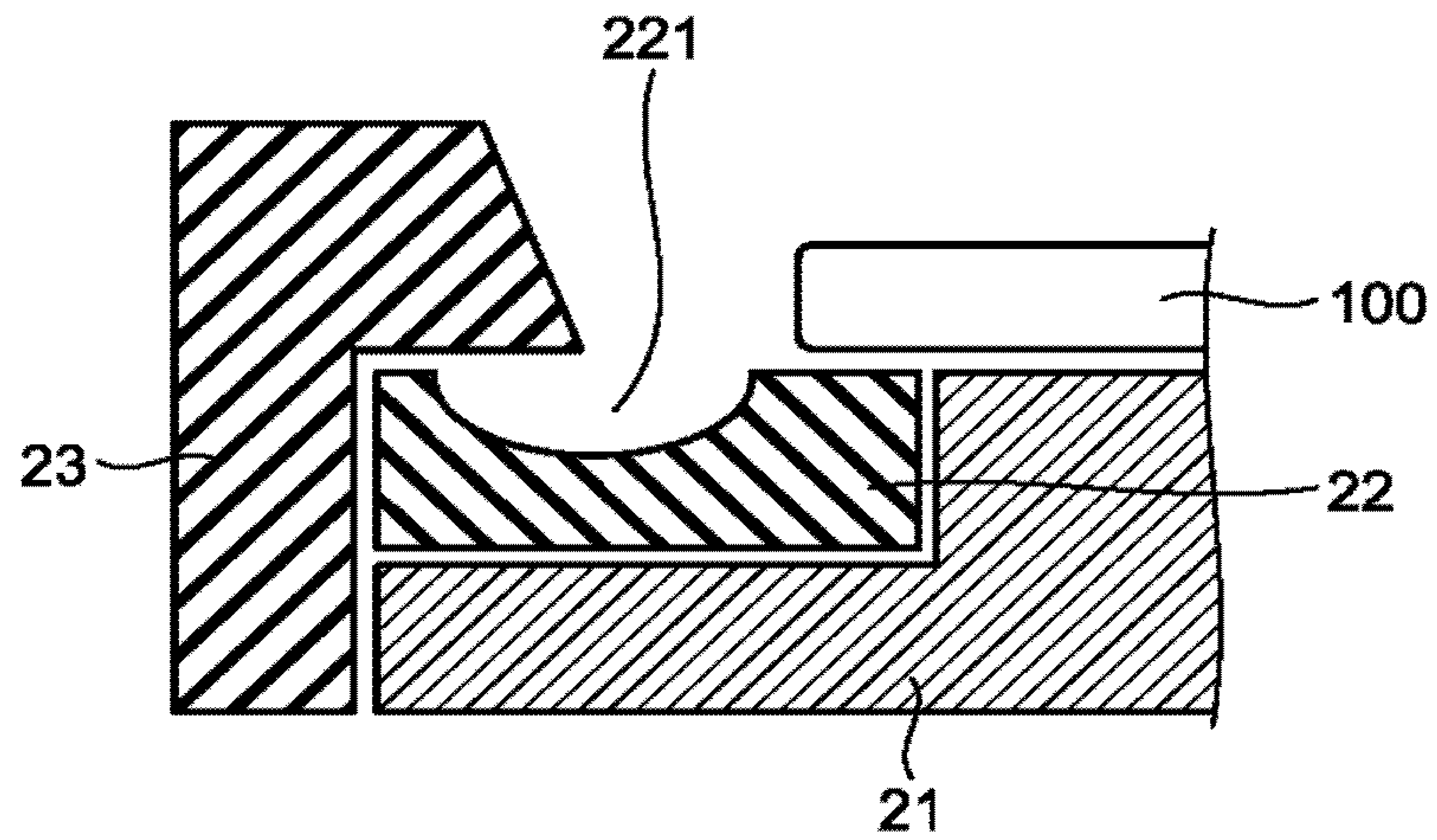


FIG.3A

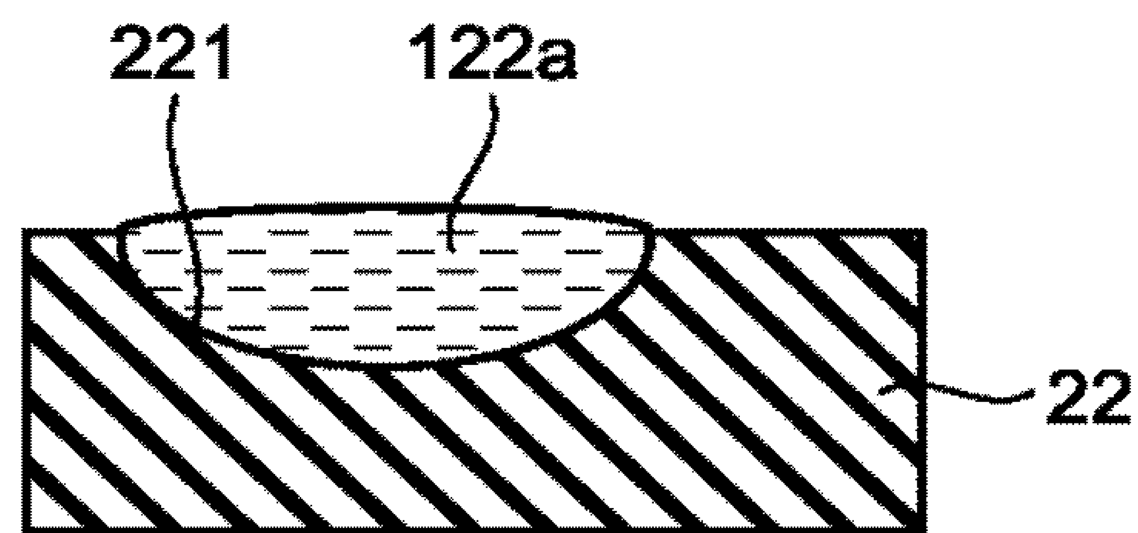


FIG.3B

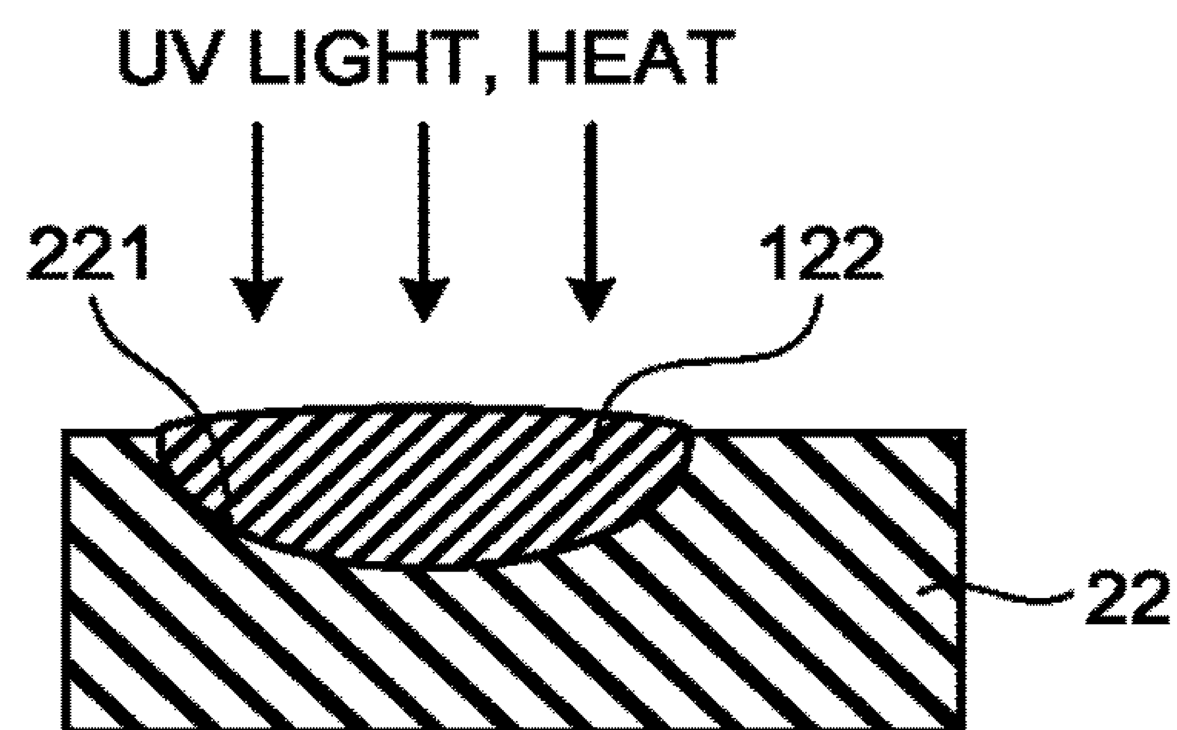


FIG.4

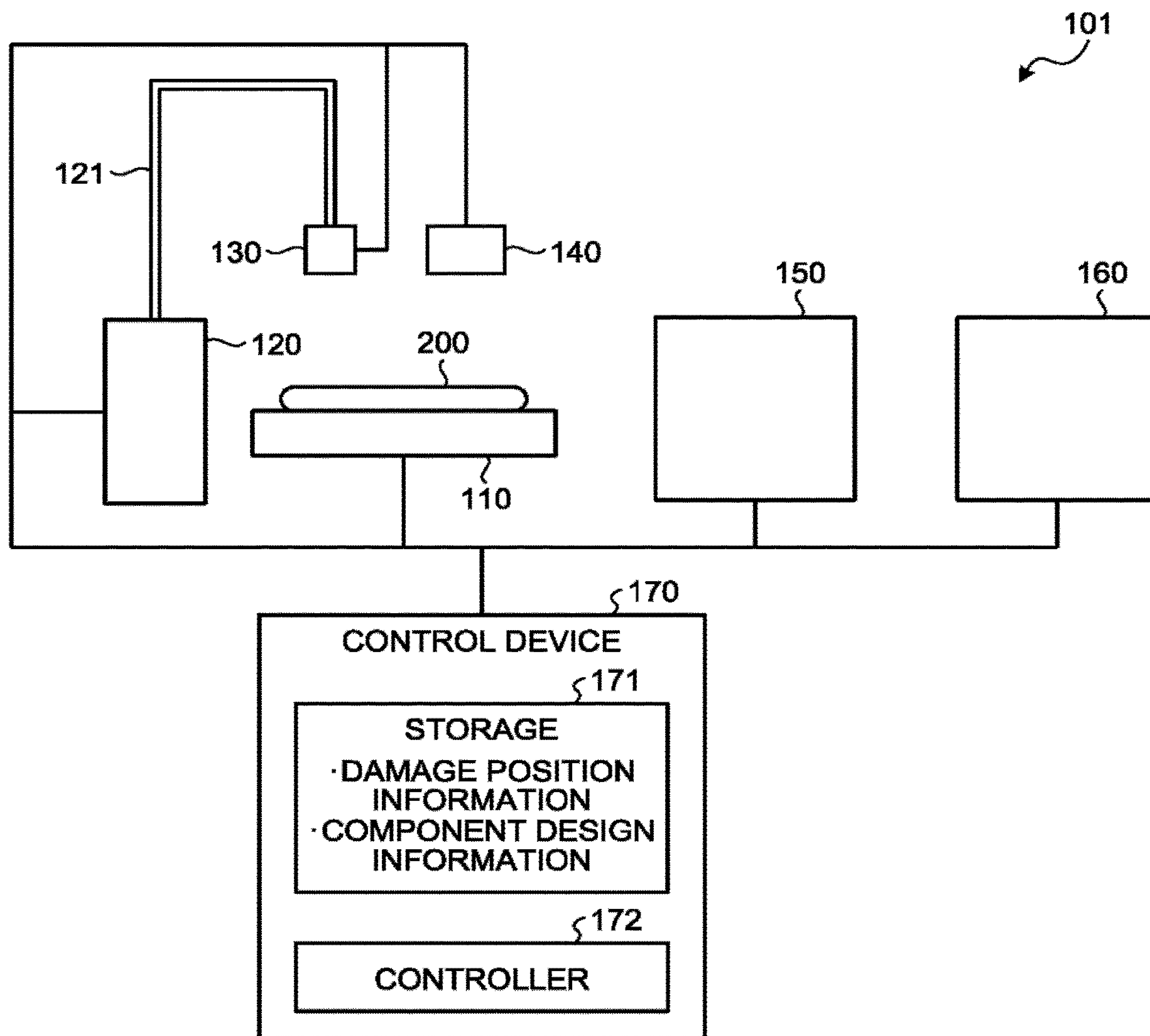


FIG.5

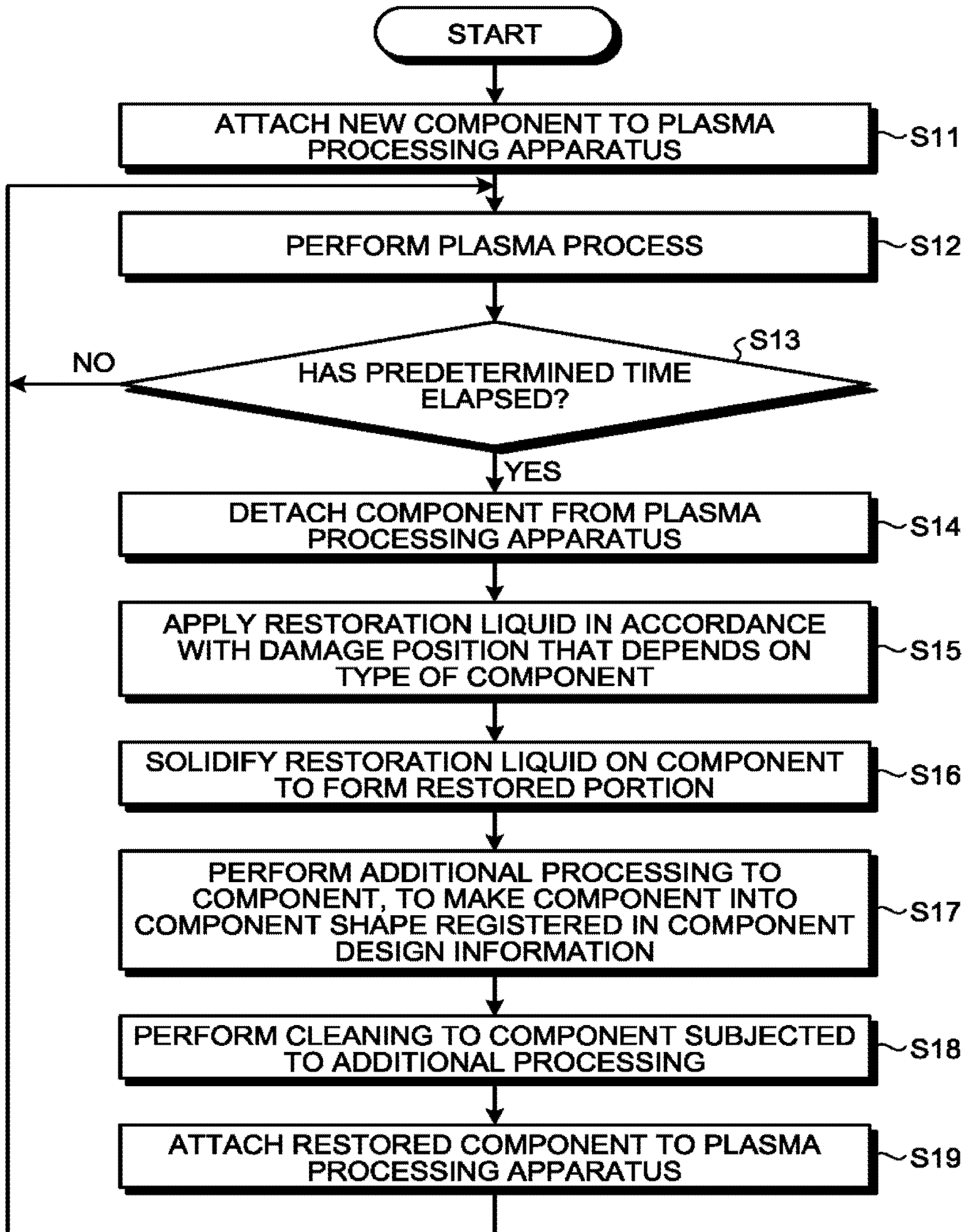


FIG.6

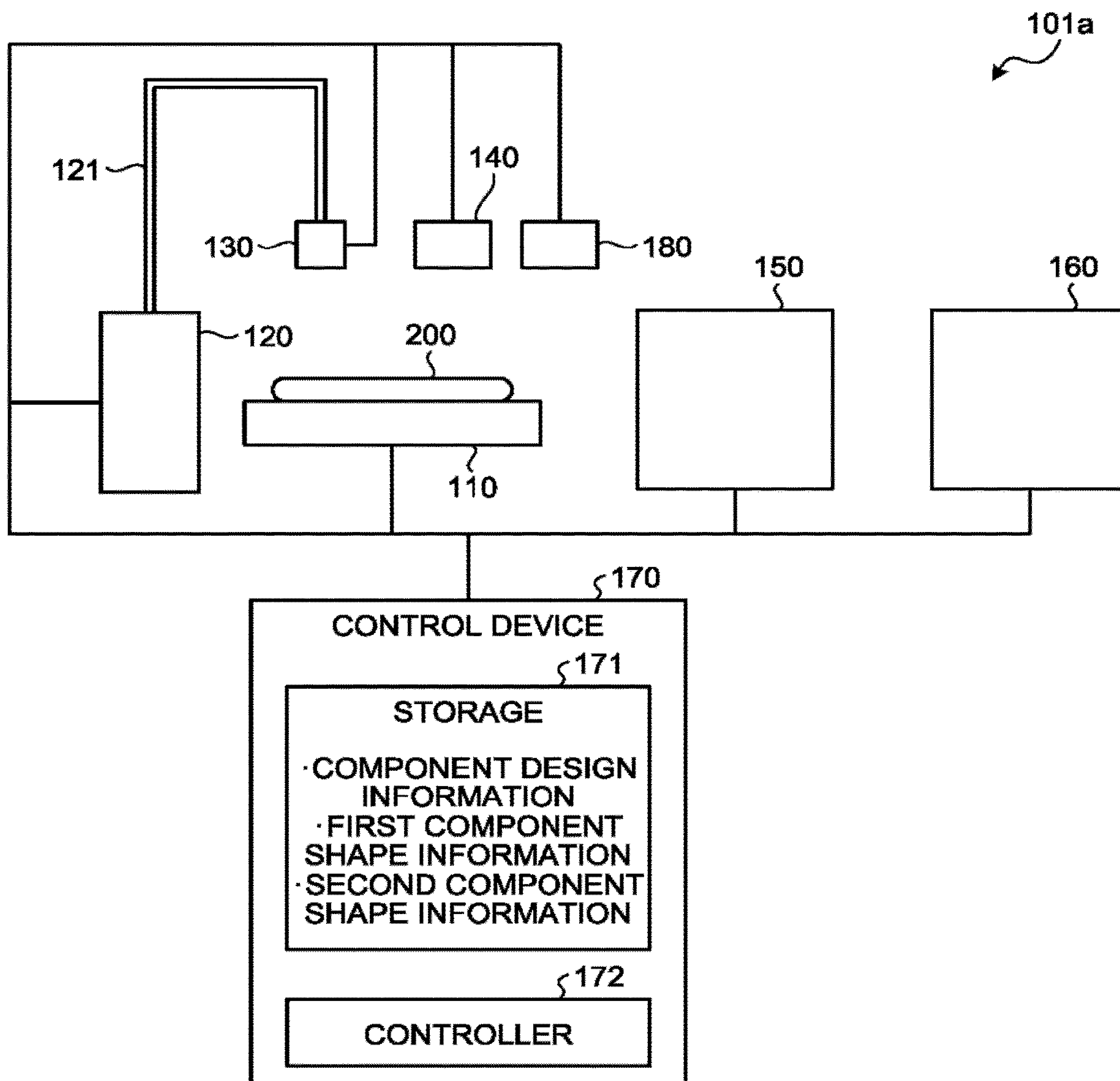
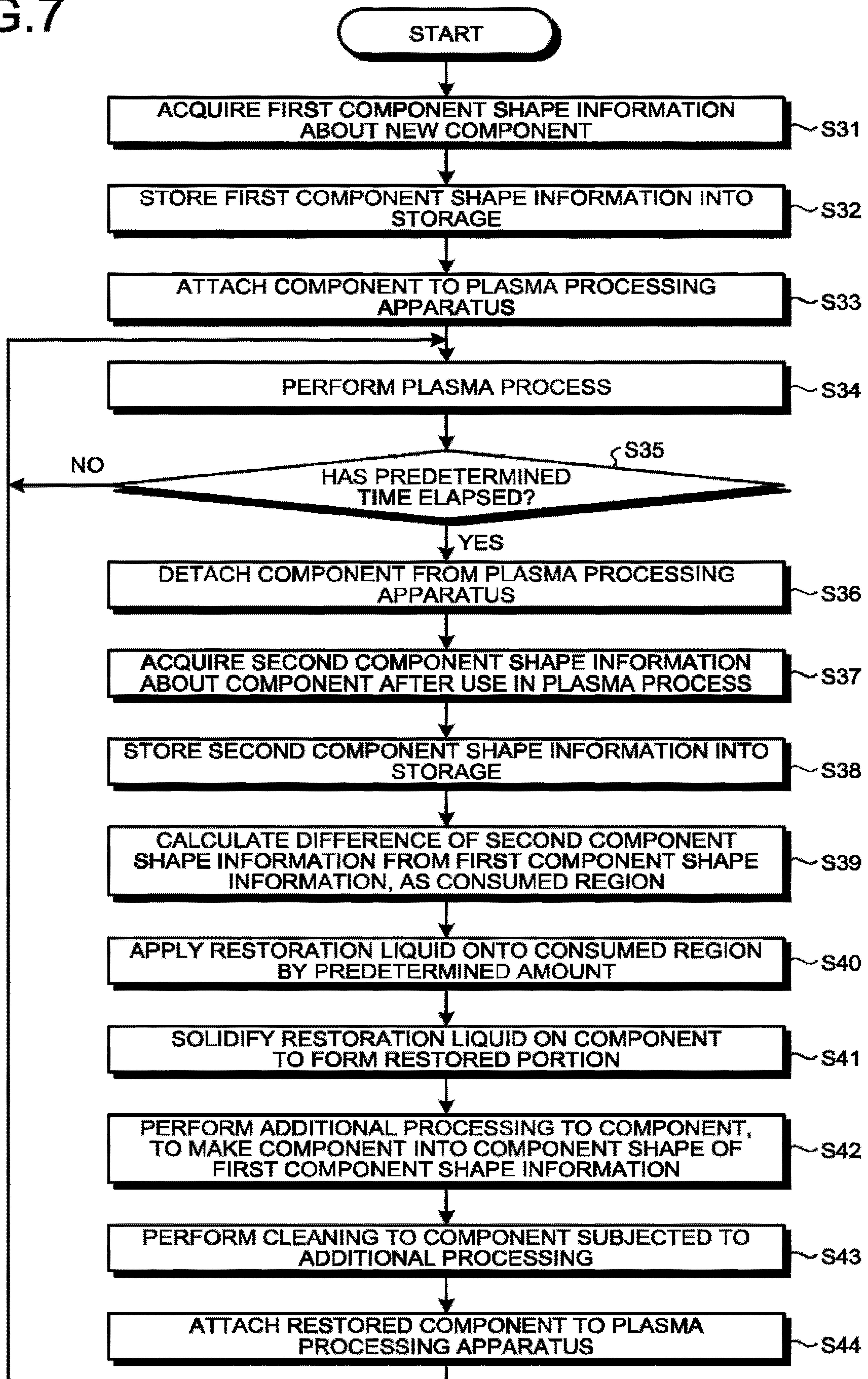


FIG.7



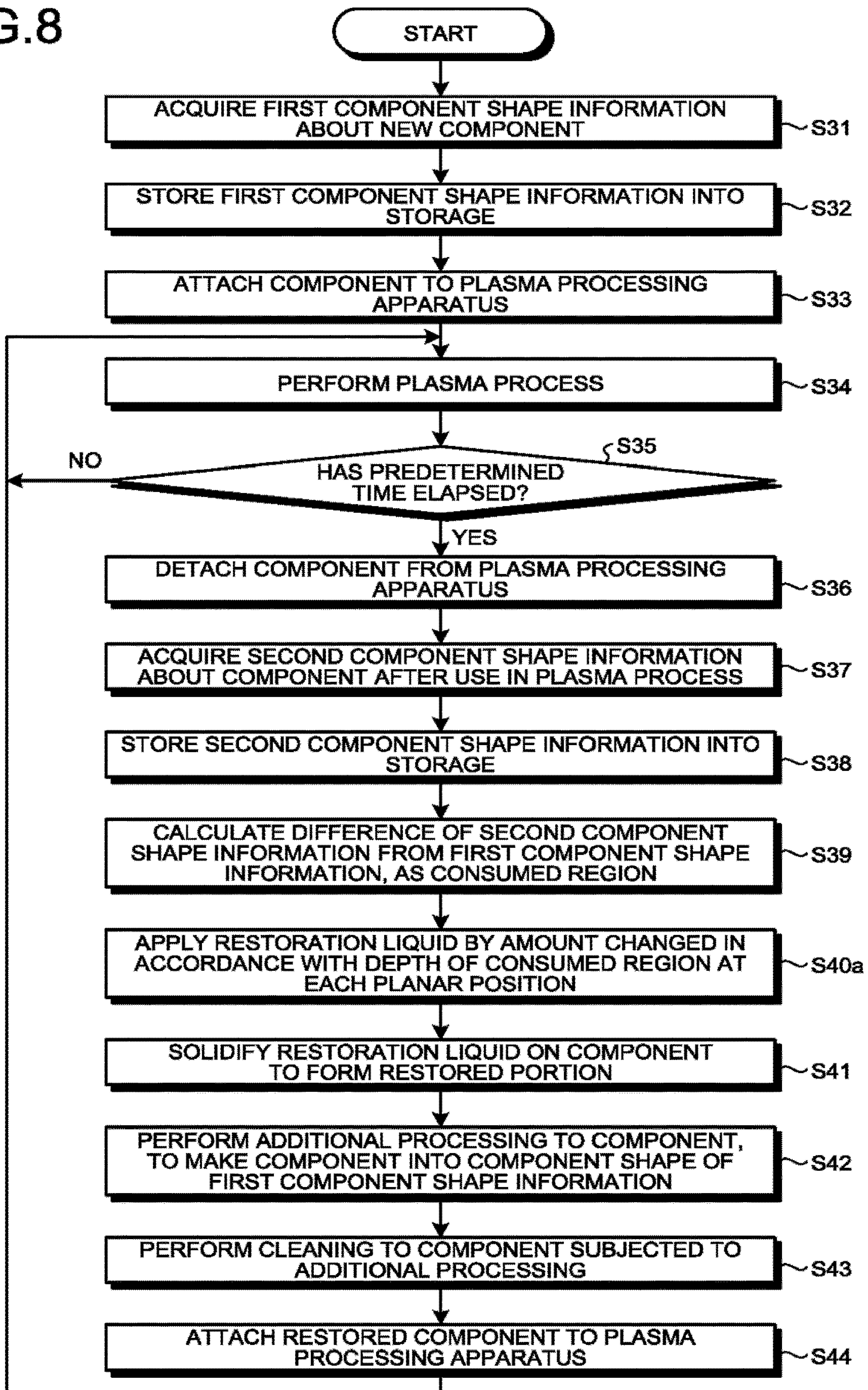
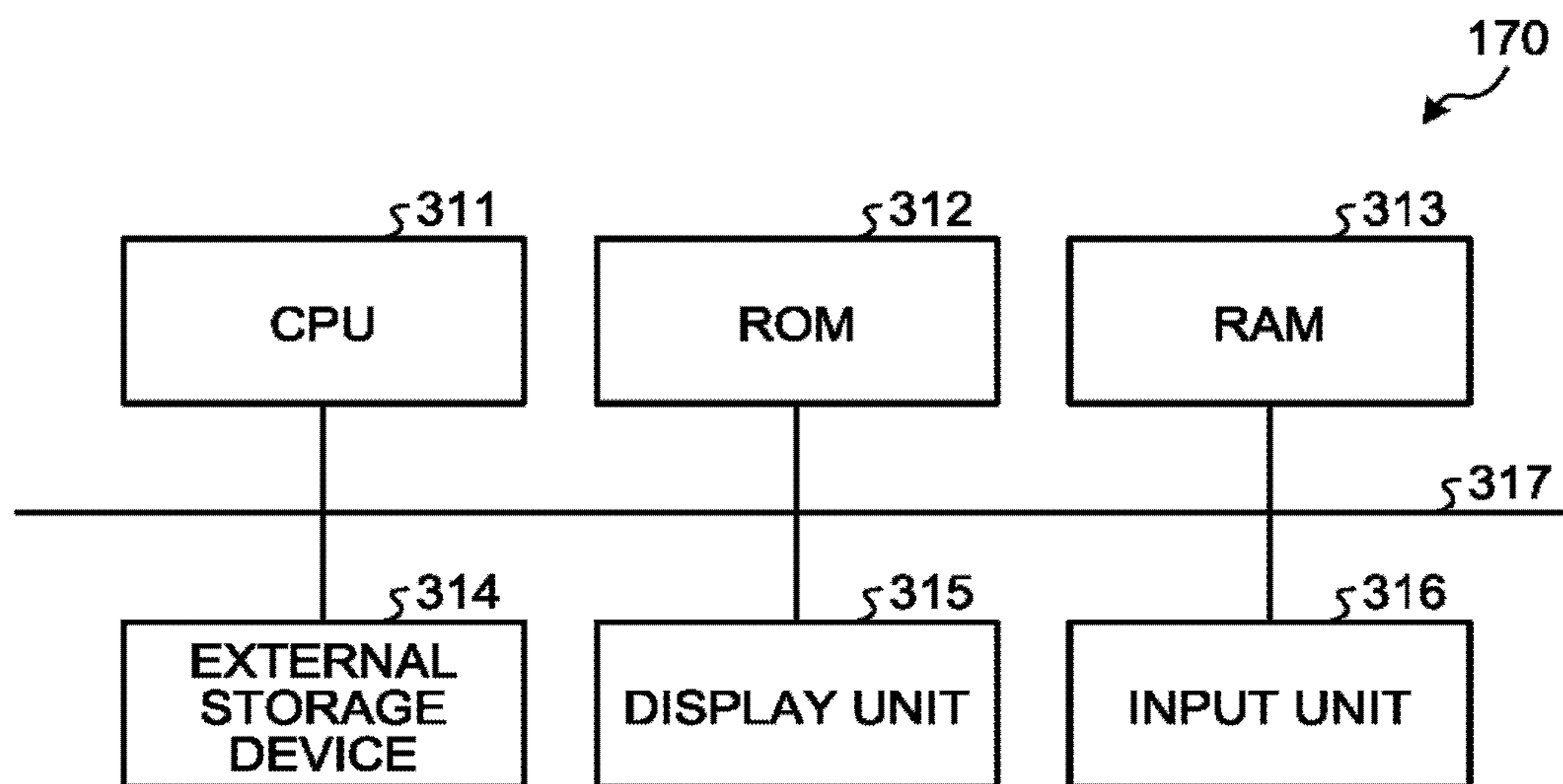


FIG.8
START
ACQUIRE FIRST COMPONENT SHAPE INFORMATION ABOUT NEW COMPONENT
S31
STORE FIRST COMPONENT SHAPE INFORMATION INTO STORAGE
S32
ATTACH COMPONENT TO PLASMA PROCESSING APPARATUS
S33
PERFORM PLASMA PROCESS
S34
HAS PREDETERMINED TIME ELAPSED?
S35
NO
YES
DETACH COMPONENT FROM PLASMA PROCESSING APPARATUS
S36
ACQUIRE SECOND COMPONENT SHAPE INFORMATION ABOUT COMPONENT AFTER USE IN PLASMA PROCESS
S37
STORE SECOND COMPONENT SHAPE INFORMATION INTO STORAGE
S38
CALCULATE DIFFERENCE OF SECOND COMPONENT SHAPE INFORMATION FROM FIRST COMPONENT SHAPE INFORMATION, AS CONSUMED REGION
S39
APPLY RESTORATION LIQUID BY AMOUNT CHANGED IN ACCORDANCE WITH DEPTH OF CONSUMED REGION AT EACH PLANAR POSITION
S40a
SOLIDIFY RESTORATION LIQUID ON COMPONENT TO FORM RESTORED PORTION
S41
PERFORM ADDITIONAL PROCESSING TO COMPONENT, TO MAKE COMPONENT INTO COMPONENT SHAPE OF FIRST COMPONENT SHAPE INFORMATION
S42
PERFORM CLEANING TO COMPONENT SUBJECTED TO ADDITIONAL PROCESSING
S43
ATTACH RESTORED COMPONENT TO PLASMA PROCESSING APPARATUS
S44

FIG.9



RESTORATION METHOD FOR PLASMA PROCESSING APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is based upon and claims the benefit of priority from Japanese Patent Application No. 2018-114256, filed on Jun. 15, 2018; the entire contents of which are incorporated herein by reference.

FIELD

Embodiments described herein relate generally to a restoration apparatus and a restoration method for a plasma processing apparatus.

BACKGROUND

Conventionally, a technique is known which coats the ceramic surface with a layer containing SiC.

In a plasma processing apparatus, since plasma is generated above a support member to perform an etching process, etching comes to be applied not only to a wafer but also to a component, such as an edge ring, around the wafer. Thus, there is a demand for a technique for performing restoration of the etched component easily.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a sectional view schematically illustrating a configuration example of a plasma processing apparatus;

FIG. **2** is a partial sectional view schematically illustrating the state of an edge ring in a plasma process;

FIGS. **3**A and **3**B are diagrams for explaining an outline of a restoration method for a plasma processing apparatus, according to a first embodiment;

FIG. **4** is a diagram schematically illustrating a configuration example of a restoration apparatus for a plasma processing apparatus, according to the first embodiment;

FIG. **5** is a flowchart illustrating an example of the sequence of a component restoration method according to the first embodiment;

FIG. **6** is a diagram schematically illustrating a configuration example of a restoration apparatus for a plasma processing apparatus, according to a second embodiment;

FIG. **7** is a flowchart illustrating an example of the sequence of a component restoration method according to the second embodiment;

FIG. **8** is a flowchart illustrating an example of the sequence of a component restoration method according to a third embodiment; and

FIG. **9** is a diagram illustrating a hardware configuration example of a control device.

DETAILED DESCRIPTION

According to one embodiment, a restoration apparatus for a plasma processing apparatus includes a coating part, a solidifying part, and a controller. The coating part is configured to apply a restoration liquid onto a consumed region on a component serving as a constituent element of the plasma processing apparatus. The solidifying part is configured to solidify the restoration liquid applied on the component. The controller is configured to control application of the restoration liquid from the coating part onto the consumed region on the component.

Exemplary embodiments of a restoration apparatus and a restoration method for a plasma processing apparatus will be explained below in detail with reference to the accompanying drawings. The present invention is not limited to the following embodiments.

First Embodiment

FIG. **1** is a sectional view schematically illustrating a configuration example of a plasma processing apparatus. Here, the plasma processing apparatus is exemplified by a Reactive Ion Etching (RIE) apparatus, which is an example of a dry etching apparatus. The plasma processing apparatus **10** includes a chamber **11** made of, e.g., aluminum and structured airtight. This chamber **11** is grounded.

The chamber **11** is provided with a support table **21** inside, which is configured to support an object substrate **100** to be treated as a processing object in a horizontal state, and to function as a lower electrode. The support table **21** is equipped with a holding mechanism (not illustrated) on its surface, such as an electrostatic chuck mechanism for attracting and holding the object substrate **100** by an electrostatic force. The support table **21** has a shape formed of two circular columns, which are different in diameter and stacked up and down. Specifically, the support table **21** has a structure integrally formed of a larger-diameter portion **21***a* having a first diameter and a smaller-diameter portion **21***b* having a second diameter smaller than the first diameter. The smaller-diameter portion **21***b* is arranged on the upper side, and the upper surface of the smaller-diameter portion **21***b* serves as a mounting surface for the object substrate **100**. Here, the mounting surface for the object substrate **100** has a circular shape smaller than the area of the object substrate **100** to be placed on the support table **21**. On the other hand, the upper surface of the larger-diameter portion **21***a* serves as a mounting surface for an edge ring **22**.

The edge ring **22** is disposed on the upper surface of the larger-diameter portion **21***a* of the support table **21**. The height of the smaller-diameter portion **21***b* has been adjusted so that the upper surface of the support table **21** and the upper surface of the edge ring **22** can be almost flush with each other. The edge ring **22** is a member provided to adjust an electric field, during etching to the object substrate **100**, such that the electric field is not deflected in the vertical direction (the direction perpendicular to the plane of the object substrate **100**) at the peripheral portion of the object substrate **100**. The edge ring **22** is made of an insulating material, such as SiC. Further, an insulator ring **23** made of an insulating material, such as quartz, is provided, such that the insulator ring **23** covers the side surface of the support table **21** with the edge ring **22** mounted thereon, and the peripheral portion of the upper surface of the edge ring **22**.

Further, the support table **21** is secured by a support frame **24** in a state positioned at about the center inside the chamber **11**. The support table **21** is connected to a feeder line **31** for supplying a radio frequency power, and this feeder line **31** is connected to a blocking capacitor **32**, a matching device **33**, and a radio frequency power supply **34**. The radio frequency power supply **34** is configured to supply a radio frequency power having a predetermined frequency to the support table **21**.

An upper electrode **42** is provided above the support table **21**, and faces the support table **21** functioning as the lower electrode. The upper electrode **42** is secured by a member **41**, which is provided near the upper side of the chamber **11** and separated from the support table **21** by a predetermined distance, such that the upper electrode **42** and the support

table **21** face each other in parallel. With this structure, the upper electrode **42** and the support table **21** constitute a pair of parallel-plate electrodes. Further, the upper electrode **42** includes a plurality of gas supply passages (not illustrated) formed therein and penetrating the upper electrode **42** in the thickness direction. The upper electrode **42** has a circular plate shape, for example. The upper electrode **42** is an electrode made of silicon, for example.

The chamber **11** is provided with a gas supply port **12** above the arrangement position of the upper electrode **42**, to supply a processing gas for use in a plasma process. The gas supply port **12** is connected to a gas supply unit (not illustrated) through a pipe.

The chamber **11** is provided with a gas exhaust port **14** on the lower side. The gas exhaust port **14** is connected to a vacuum pump (not illustrated) through a pipe.

The chamber **11** is provided with an opening **15** on a side surface, through which, for example, the object substrate **100** is loaded or unloaded, and the opening **15** is provided with a shutter **52**. The shutter **52** serves to separate the outside and inside of the chamber **11** from each other, and can be opened to connect the opening **15** to the inside of the chamber **11** when the object substrate **100** is to be loaded or unloaded.

Next, an explanation will be given of an outline of a process in the plasma processing apparatus **10** configured as described above. FIG. **2** is a partial sectional view schematically illustrating the state of the edge ring in a plasma process. First, an object substrate **100** to be treated as a processing object is placed on the support table **21**, and is fixed by the electrostatic chuck mechanism, for example. Then, the inside of the chamber **11** is vacuum-exhausted by the vacuum pump (not illustrated) connected to the gas exhaust port **14**.

Thereafter, when the inside of the chamber **11** reaches a predetermined pressure, a process gas is supplied from the gas supply unit (not illustrated), through the gas delivery ports of the upper electrode **42**, into the space between the upper electrode **42** and the support table **21**. Then, in a state where the upper electrode **42** is grounded, a radio frequency voltage is applied to the support table **21** (lower electrode), so that plasma is generated in the space between the upper electrode **42** and the support table. Here, a potential gradient is generated between the plasma and the object substrate **100**, on the lower electrode side, due to a self bias caused by the radio frequency voltage. Consequently, ions in the plasma gas are accelerated toward the support table **21**, and an anisotropic etching process is thereby performed.

At this time, not only the object substrate **100** but also the edge ring **22** present around are etched. As the edge ring **22** is kept used for a long time, that part of the upper surface of the edge ring **22**, which is exposed to plasma, is etched and thereby damaged, as illustrated in FIG. **2**. Consequently, a recessed region **221** is formed at the damaged place, as illustrated in FIG. **2**. As compared with plasma process characteristics acquired when the edge ring **22** is used in the brand new state, the plasma process characteristics are deteriorated when the edge ring **22** is used in a damaged state. In consideration of this, in this embodiment, an explanation will be given of a method for performing restoration and reuse of a component, such as the edge ring **22**, damaged by a plasma process.

FIGS. **3**A and **3**B are diagrams for explaining an outline of a restoration method for a plasma processing apparatus, according to the first embodiment. In the first embodiment, when restoration is performed to a component for use in the plasma processing apparatus **10**, a restoration liquid is used, which contains an ingredient to be turned into an inorganic film by crosslinking or polymerization. As this restoration liquid, liquid SiC or Spin On Glass (SOG) solution may be used.

The liquid SiC is a mixed solution of a silicon-containing material that contains silicon, with a carbon-containing material in a liquid state that contains carbon. The liquid SiC is a material that is turned into an SiC film by crosslinking or polymerization. The silicon-containing material is made of at least one species selected from the group consisting of cyclopentasilane, cyclohexasilane, neo-pentasilane, and polyhydrosilane.

The carbon-containing material is in a liquid state at room temperature and atmospheric pressure (for example, 25° C., 1,013 hPa), and is made of at least one species selected from the group consisting of a cyclic hydrocarbon compound expressed by general formula of C_nH_{2n-2} or C_nH_{2n-4} where "n" is 5 or more, and a chain hydrocarbon compound expressed by general formula C_nH_{2n} or C_nH_{2n-2} where "n" is 5 or more. Further, for the carbon-containing material, some of the hydrogen atoms in the cyclic hydrocarbon compound or chain hydrocarbon compound described above may be replaced with a well known substituent. For example, the carbon-containing material is made of at least one species selected from the group consisting of cyclohexene, 1-hexyne, 2-hexyne, 3-hexyne, cyclopenten, cyclooctene, 1,3-cyclopentadiene, 1,3-cyclohexadiene, 1,4-cyclohexadiene, 1-hexene, 2-hexene, 3-hexene, 1,3-hexadiene, 1,4-hexadiene, and 1,5-hexadiene.

The SOG solution is a material that is turned into an SiO_2 film in a glassy state by crosslinking or polymerization. For example, the SOG solution may be exemplified by polysilazane-based SOG, silicate-based SOG, alkoxysilicate-based SOG, and/or the like.

Hereinafter, a case will be taken as an example where the liquid SiC is used as the restoration liquid. As illustrated in FIG. **3**A, the liquid SiC **122***a* is applied onto the edge ring **22** that is a damaged component. For example, as explained with reference to FIG. **2**, when the recessed region **221** has been formed in the edge ring **22** due to a plasma process, the liquid SiC **122***a* is applied to fill up the recessed region **221**.

Then, as illustrated in FIG. **3**B, the liquid SiC **122***a* is subjected to heat application or light irradiation. Consequently, the liquid SiC **122***a* is dehydrogenated, and an SiC film **122** is thereby formed in the recessed region **221**. In the case of the SiC film **122** thus formed, since there is no need to use any metal catalyst, metal contamination is prevented from occurring. As a result, it is possible to acquire SiC under high purity physicality control. In this way, the damaged component is restored. As SiC is a substance high in hardness, resistant to heat, and stable in chemistry, the component thus restored can be used again for the plasma processing apparatus **10**.

FIG. **4** is a diagram schematically illustrating a configuration example of a restoration apparatus for a plasma processing apparatus, according to the first embodiment. The restoration apparatus **101** includes a stage **110**, a restoration liquid storage part **120**, a coating part **130**, a solidifying part **140**, an additional processing section **150**, a cleaning section **160**, and a control device **170**.

The stage **110** is configured to place thereon a component **200** to be treated as a processing object. The component **200** is a component for serving as a constituent element of the plasma processing apparatus **10**, such as the edge ring **22** or insulator ring **23**. The component is a component damaged by plasma because of use for a predetermined time in the plasma processing apparatus **10**.

The restoration liquid storage part **120** stores a restoration liquid. The coating part **130** is configured to apply the restoration liquid onto the component **200**. The coating part **130** is formed of a nozzle, for example. The coating part **130** is connected to the restoration liquid storage part **120** by a pipe **121**. In accordance with an instruction from the control device **170**, the coating part **130** applies the restoration liquid from the restoration liquid storage part **120** onto a consumed region on the component **200**. The stage **110** and the coating part **130** are configured to change relative positions therebetween as required.

The solidifying part **140** is configured to solidify the restoration liquid applied on the component **200**, by using heat or light. For example, the solidifying part **140** is formed of a heater, or a light source for emitting light having a wavelength that can solidify the restoration liquid. Hereinafter, the restoration liquid solidified by heat or light on the component **200** will be referred to as "restored portion".

The additional processing section **150** is arranged to perform processing to the component **200** including a restored portion formed thereon, to make the component **200** into a shape the same as that of the component **200** in the brand new state. This is because the restored portion solidified on the component **200** does not necessarily have a desired shape. The additional processing section **150** performs processing to the component **200** including the restored portion formed thereon, in accordance with the design drawings or dimension drawings of the component **200**. As the additional processing, for example, cutting, polishing, and/or the like are performed. The additional processing section **150** is formed of a lathe turning machine or machining center, for example. The cleaning section **160** is arranged to perform cleaning to the component **200** subjected to the additional processing.

The control device **170** is configured to control the restoration apparatus **101** as a whole. For example, the control device **170** moves the stage **110** and the coating part **130** relative to each other, controls the amount of restoration liquid to be delivered from the coating part **130**, controls the operation of the solidifying part **140**, and so forth. Further, the control device **170** controls the additional processing in the additional processing section **150**, and the cleaning in the cleaning section **160**.

The control device **170** includes a storage **171** and a controller **172**. The storage **171** stores damage position information that indicates a damage position on each component **200**, and component design information that shows the shape of each component in the brand new state. For example, the damage position information is information that indicates a position to be damaged on each component **200** in the plasma processing apparatus **10**. For example, as illustrated in FIG. **2**, the damage position on the edge ring **22** is almost constant. Accordingly, in such a case, information about this damage position is registered in advance in the storage **171**. The component design information is design information that shows the size, angle, bending degree, and so forth of each component **200**. The component design information is information showing the shape that each component **200** has in the brand new state. Here, where there are a plurality of types of components **200**, the damage position information becomes information that correlates identification information indicating the types of components **200** with damage positions on the respective components **200**. Further, the component design information becomes information that correlates identification information indicating the types of components **200** with the shapes of the respective components **200**.

With respect to each component **200**, the controller **172** obtains the corresponding damage position information from the storage **171**. Then, the controller **172** controls the position of the coating part **130** relative to the component **200** and the amount of restoration liquid to be supplied from the restoration liquid storage part **120**, to apply the restoration liquid onto the damage position on the component by a predetermined amount. Where there are a plurality of types of components **200**, the controller **172** obtains the damage position information corresponding to the identification information of a component **200** placed on the stage **110**, from the storage **171**, and then performs control on the basis of the damage position information thus obtained.

Further, when solidifying the restoration liquid by heat, the controller **172** increases the temperature from the component **200** side. The controller **172** stops the temperature increase at a temperature lower than the solidification temperature of the restoration liquid, and maintains this temperature for a predetermined time. The predetermined time for maintaining this temperature is from ten seconds to ten minutes, for example. After the predetermined time has elapsed, the controller **172** performs temperature increase to increase the temperature gradually to a temperature higher than the solidification temperature of the restoration liquid. Thereafter, the controller **172** stops the temperature increase, and maintains this temperature for a predetermined time. The predetermined time for maintaining this temperature is from ten seconds to ten minutes, for example. Here, where lamp heating is used, the controller **172** performs heating by selecting a wavelength that can be easily absorbed not by the restoration liquid but by the component **200**. When the heating is performed in this way, solidification of the restoration liquid is developed from the interface with the component **200**, so that the strain inside the solidified and restored portion becomes smaller. As a result, the restored portion becomes less likely to peel off from the component **200**.

On the other hand, when solidifying the restoration liquid by light, the controller **172** selects light having a wavelength longer than that of the absorption edge of the restoration liquid, and thereby controls irradiation for the component **200**. When light having such a wavelength is used, although solidification of the restoration liquid is developed from the surface irradiated with light, the solidify speed is low, so that the strain inside the solidified and restored portion becomes smaller.

For the processing in the additional processing section **150**, as in the ordinary lathe turning machine or machining center, the controller **172** obtains the component design information corresponding to the identification information of the component **200**, from the storage **171**, and then conducts additional processing to the component **200** in accordance with the component design information thus obtained.

Next, an explanation will be given of a component restoration method in the restoration apparatus **101** described above. FIG. **5** is a flowchart illustrating an example of the sequence of a component restoration method according to the first embodiment. First, an unused component in the brand new state is attached to the plasma processing apparatus **10** (step S**11**), and then a plasma process is performed (step S**12**). Thereafter, it is determined whether the plasma process has been performed for a predetermined time since the component was attached to the plasma processing apparatus **10** (step S**13**). When the plasma process has not yet been performed for the predetermined time (No at step S**13**), a waiting state follows, and

the processing sequence returns to step **S12**. On the other hand, when the plasma process has been performed for the predetermined time (Yes at step **S13**), the component is detached from the plasma processing apparatus **10** (step **S14**).

Then, the component is transferred to the restoration apparatus **101**, and is placed on the stage **110**. Thereafter, the controller **172** obtains the damage position information corresponding to the type of the component, from the storage **171**. Then, the restoration liquid is applied from the coating part **130** onto the component, in accordance with this damage position information (step **S15**). For example, in order to apply the restoration liquid by a predetermined amount onto the damage position prescribed in the damage position information, the positions of the component and the coating part **130** and the application amount of the restoration liquid are controlled.

Then, under the control of the controller **172**, the solidifying part **140** solidifies the restoration liquid on the component to form a restored portion (step **S16**). The solidification of the restoration liquid is performed, for example, by heating the restoration liquid on the component, or by irradiating the restoration liquid on the component with light having a predetermined wavelength. By the solidification of the restoration liquid, the consumed region on the component is provided with the restored portion. At this time, where a heater embedded in the stage **110** is used as the solidifying part **140**, the controller **172** controls the heater. For example, the controller **172** controls the heater, as follows: The heater stops temperature increase at a temperature lower than the solidification temperature of the restoration liquid; maintains this temperature for ten seconds to ten minutes, for example; thereafter, stops temperature increase at a temperature higher than the solidification temperature of the restoration liquid; and maintains this temperature for ten seconds to ten minutes, for example. Alternatively, where lamp heating is used for the solidifying part **140**, the controller **172** selects a wavelength that can be easily absorbed not by the restoration liquid but by the component, and performs control to irradiate the component by the heating. Alternatively, where a light source is used as the solidifying part **140**, the controller **172** selects light having a wavelength longer than that of the absorption edge of the restoration liquid, and performs control to irradiate the component with the light.

Thereafter, under the control of the controller **172**, the additional processing section **150** performs additional processing to the component including the restored portion formed thereon, to make the component into the component shape registered in the component design information (step **S17**). For example, the additional processing section **150** performs an additional processing treatment, such as grinding, polishing, or the like to a place protruding from the surrounding surface. After the additional processing treatment, under the control of the controller **172**, the cleaning section **160** performs cleaning to the component subjected to the additional processing (step **S18**). Consequently, the component is restored.

Then, the restored component is attached to the plasma processing apparatus **10** again, and is reused (step **S19**). Thereafter, the processing sequence returns to step **S12**.

It should be noted that the restored portion may be made of a material the same as that of the component, or a material different from that of the component. For example, in the case of an edge ring made of SiC, the restored portion may be made of SiC, or may be made of SiO_2. Further, in the case of an insulator ring **23** made of SiO_2, the restored portion may be made of SiO_2, or may be made of SiC.

Further, before the restoration liquid is applied in step **S15**, the component may be heated. For example, the conditions for this heating may include a temperature from one hundred to several hundred degrees ° C., and a time from five to thirty minutes. The method for this heating may be selected from various methods, such as heating by a heater, and lamp heating. Consequently, moisture at the interface of the component is removed. Further, when the component is reused in step **S19**, if the shape of the component is horizontally symmetric and vertically symmetric, as in the edge ring **22**, the surface of the component with the restored portion formed thereon may be oriented upward, or may be oriented downward, in placement of the component. For example, where the restored portion is made of SiC, the surface with the restored portion formed thereon may be oriented upward, or may be oriented downward. However, where the restored portion is made of SiO_2, the surface with the restored portion formed thereon is preferably oriented downward.

As described above, in the first embodiment, the restoration liquid is applied onto the consumed region on a component for use in the plasma processing apparatus **10**, and is then solidified, to restore the component. Consequently, an effect is provided to make it possible to attach the component to the plasma processing apparatus **10** again, and to reuse the component.

Second Embodiment

In the first embodiment, an explanation has been given of a restoration apparatus and a restoration method for a plasma processing apparatus on the premise that the damage position on a component is almost constant for every type of component. In the second embodiment, an explanation will be given of a case where restoration of a component is performed by confirming a damage position on each component to be restored.

FIG. **6** is a diagram schematically illustrating a configuration example of a restoration apparatus for a plasma processing apparatus, according to the second embodiment. The restoration apparatus **101***a* includes a component shape acquiring part **180** for acquiring the shape of a component **200**, in addition to the configuration according to the first embodiment. The component shape acquiring part **180** is configured to acquire the shape of a component **200** in the brand new state and the shape of the component **200** in a damaged state, and to sore these shapes into a storage **171** of the control device **170**. For example, the component shape acquiring part **180** is formed of an image pickup device, such as camera. In this case, information about the shape of each component **200** is image data. For example, this image data is a picked-up image of a surface of the component **200**, which is exposed during a plasma process.

Here, the control device **170** includes the storage **171** and a controller **172**. The storage **171** stores component design information, first component shape information, and second component shape information. The component design information is substantially the same as that described in the first embodiment. The first component shape information contains identification information indicating the type of each component, for example, and shape data about the component **200** in the brand new state. The second component shape information contains identification information indi-

cating the type of each component, for example, and shape data about the component **200** after use in the plasma process.

The controller **172** includes a function to acquire the position of a consumed region on a component, in addition to the function to control the restoration apparatus **101**a as a whole as described in the first embodiment. Specifically, when the second component shape information is acquired by the component shape acquiring part **180**, the controller **172** compares this second component shape information with the first component shape information of the corresponding component, and acquires the position of a consumed region. For example, where each of the first component shape information and the second component shape information is image data, the position of the edge of the component **200** is acquired, and the difference of the edge in the second component shape information, with respect to the edge in the first component shape information, is regarded as the consumed region. Further, the position of the consumed region is superimposed onto the first component shape information so that the position of the consumed region on the component **200** can be specified. When applying the restoration liquid, the controller **172** applies the restoration liquid on the basis of this position of the consumed region. Here, the constituent elements corresponding to those described in the first embodiment are denoted by the same reference symbols, and their description will be omitted.

Next, an explanation will be given of a component restoration method in the restoration apparatus **101**a described above. FIG. **7** is a flowchart illustrating an example of the sequence of a component restoration method according to the second embodiment. First, an unused component, i.e., a component in the brand new state is placed on the stage **110** of the restoration apparatus **101**a, and its shape data, i.e., first component shape information is acquired by the component shape acquiring part **180** (step S**31**). The first component shape information thus acquired is stored into the storage **171** (step S**32**).

Thereafter, the processing sequence is executed in substantially the same way as that of steps S**11** to S**14** in FIG. **5** according to the first embodiment (steps S**33** to S**36**). Specifically, the component is attached to the plasma processing apparatus **10**, and then a plasma process is performed. Thereafter, when the plasma process has been performed for a predetermined time since the component was attached to the plasma processing apparatus **10**, the component is detached from the plasma processing apparatus **10**.

Then, the component after use in the plasma process is placed on the stage **110** of the restoration apparatus **101**a, and its shape, i.e., second component shape information is acquired by the component shape acquiring part **180** (step S**37**). The second component shape information thus acquired is stored into the storage **171** (step S**38**). Thereafter, the controller **172** reads the first component shape information and the second component shape information from the storage **171**, and calculates the difference of the second component shape information from the first component shape information, as a consumed region (step S**39**).

Then, under the control of the controller **172**, the coating part **130** applies the restoration liquid by a predetermined amount onto the consumed region thus calculated (step S**40**). Thereafter, the processing sequence is executed in substantially the same way as that of steps S**16** to S**19** in FIG. **5** according to the first embodiment (steps S**41** to S**44**). Specifically, the solidifying part **140** solidifies the restoration liquid on the component. The additional processing section **150** performs additional processing to the component, to make the component into the component shape registered in the component design information. The cleaning section **160** performs cleaning to the component subjected to the additional processing. Then, the restored component is attached to the plasma processing apparatus **10** again, and is reused. Thereafter, the processing sequence returns to step S**34**.

As described above, in the second embodiment, the first component shape information about a component in the brand new state and the second component shape information about the component after use in a plasma process are compared with each other, to acquire the position of a consumed region. Then, the restoration liquid is applied onto the component, on the basis of this position of the consumed region. Consequently, the restoration liquid is not applied onto a non-consumed region, and thus the consumption amount of the restoration liquid can be smaller, as compared with the first embodiment.

Third Embodiment

In the second embodiment, it has been assumed that each of the first component shape information and the second component shape information is image data. According, when these two pieces of information are compared with each other, the position of a consumed region can be acquired, but the depth of the consumed region illustrated in FIG. **2**, for example, cannot be acquired. In the third embodiment, an explanation will be given of a restoration apparatus and a restoration method for a plasma processing apparatus, which can acquire information further containing the depth of a consumed region.

A restoration apparatus **101**a for a plasma processing apparatus according to the third embodiment has a configuration substantially the same as that illustrated in FIG. **6** according to the second embodiment. However, the component shape acquiring part **180** is configured to acquire, as shape data about a component, the state of depressions and/or protrusions on at least a surface of the component, which is exposed during a plasma process. The component shape acquiring part **180** of this type may be exemplified by a three-dimensional measuring instrument.

Accordingly, the controller **172** can acquire a consumed region from the difference between the first component shape information and the second component shape information. Here, information about this consumed region contains not only the position of the consumed region within the planar positions of the component, but also the depth of the consumed region at each of the planar positions. Then, when applying the restoration liquid onto the consumed region, the controller **172** controls the coating part **130** and the restoration liquid storage part **120** to change the application amount of the restoration liquid in accordance with the depth of the consumed region at the application position. Here, the other parts of the configuration are substantially the same as those described in the first and second embodiments.

Next, an explanation will be given of a restoration method in the restoration apparatus **101**a for a plasma processing apparatus described above. FIG. **8** is a flowchart illustrating an example of the sequence of a component restoration method according to the third embodiment. This flowchart is basically almost the same as that described with reference to FIG. **7** according to the second embodiment, but is different at step S**40** in FIG. **7**. Specifically, in the third embodiment, as illustrated in FIG. **8**, under the control of the controller **172**, the coating part **130** applies the restoration liquid onto

a component by a certain amount, while changing this certain amount in accordance with the depth of the consumed region at each planar position (step S**40***a*). The other steps are substantially the same as those of FIG. **7**, and thus their description will be omitted.

In the third embodiment, the application amount of the restoration liquid is adjusted in accordance with the depth of the consumed region at each planar position. Consequently, it is possible to apply the restoration liquid by a suitable amount in accordance with the shape of the consumed region. As a result, the consumption amount of the restoration liquid can be smaller, as compared with the second embodiment.

FIG. **9** is a diagram illustrating a hardware configuration example of the control device. The control device **170** has a hardware configuration utilizing an ordinary computer, in which a Central Processing Unit (CPU) **311**, a Read Only Memory (ROM) **312**, a Random Access Memory (RAM) **313** serving as the main storage device, an external storage device **314**, such as a Hard Disk Drive (HDD), Solid State Drive (SSD), or Compact Disc (CD) drive device, a display unit **315**, such as a display device, and an input unit **316**, such as a keyboard and/or a mouse, are included, and are connected to each other via a bus line **317**.

A program to be executed by the control device **170** according to the embodiment has been prepared to perform the method illustrated in FIG. **5**, **7**, or **8**. This program is provided in a state recorded in a computer-readable recording medium, such as a CD-ROM, flexible disk (FD), CD-R, or Digital Versatile Disk (DVD), by a file in an installable format or executable format.

Alternatively, a program to be executed by the control device **170** according to the embodiment may be provided such that the program is stored in a computer connected to a network, such as the internet, and is downloaded via the network. Further, a program to be executed by the control device **170** according to the embodiment may be provided such that the program is provided or distributed via a network, such as the internet.

Alternatively, a program according to the embodiment may be provided in a state incorporated in a ROM or the like in advance.

While certain embodiments have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the inventions. Indeed, the novel embodiments described herein may be embodied in a variety of other forms; furthermore, various omissions, substitutions and changes in the form of the embodiments described herein may be made without departing from the spirit of the inventions. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the inventions.

What is claimed is:

1. A restoration method for a plasma processing apparatus, the method comprising:

acquiring first component shape information about a shape of a component in a brand new state, the component serving as a constituent element of the plasma processing apparatus, and second component shape information about a shape of the component after use in a plasma process;

acquiring a consumed region of the component from a difference between the first component shape information and the second component shape information;

performing an application of a restoration liquid from a coating part onto the consumed region on the component by controlling positions of the component and the coating part, and an application amount of the restoration liquid in accordance with the consumed region; and

solidifying the restoration liquid applied on the component.

2. The restoration method for a plasma processing apparatus according to claim **1**, wherein the first component shape information and the second component shape information include image data picked up by a camera, and

the consumed region is acquired from a difference between the first component shape information and the second component shape information.

3. The restoration method for a plasma processing apparatus according to claim **2**, wherein, in performing the application of the restoration liquid, an application amount of the restoration liquid is a same amount for all positions on the component.

4. The restoration method for a plasma processing apparatus according to claim **1**, wherein

the first component shape information and the second component shape information include information about a depression or protrusion on the component acquired by a three-dimensional measuring instrument,

the consumed region is acquired from a difference between the first component shape information and the second component shape information, and

an application amount of the restoration liquid is changed in accordance with a depth of the consumed region at each position on the component.

5. The restoration method for a plasma processing apparatus according to claim **1**, wherein the restoration liquid contains liquid SiC or SOG solution.

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